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Pocket gopher reoccupation of burrow systems following population reduction

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Abstract

The application of rodenticide baits to pocket gopher burrows can quickly reduce gopher density on reforestation units, but the food resources and burrow systems remain intact. This, coupled with the rodent's high reproductive and dispersal potentials, allows for rapid repopulation of treated sites. We monitored 73 pocket gopher activity plots in southern Oregon which had been rendered inactive with toxic baits. The plots promptly returned to active, indicating rapid reoccupation by gophers. Six months after baiting, 86% of plots were reoccupied. By one year post-baiting, 96% of plots were reoccupied. These results demonstrate the potential for rapid population recovery following rodenticide treatment and emphasize the need for an integration of other methods to avert damage to reforestation efforts for the long term.

Keywords: Activity assessment; Animal damage; Reforestation; *Thomomys*

1. Introduction

Pocket gophers *(Thomomys* spp.) probably account for more damage to natural or artificially planted conifers in western forests than all other animals combined (Borrecco and Black, 1990; Crouch, 1986). While pocket gophers generally are not found in densely forested areas (Barnes, 1973; Bonar, 1995), the successional vegetation, particularly perennial forbs that follow forest harvest or forest fire, substantially improves gopher habitat (e.g., Burton and Black, 1978; Ward and Keith, 1962). Reforestation problems caused by gopher foraging are largely a result of gopher populations responding to these favorable changes in their habitat (Barnes, 1973). Restocking units with conifer seedlings usually takes place within 2 yr after the stand has been harvested, resulting in seedlings being vulnerable when the habitat is rapidly improving for gophers and their densities are increasing. Unfortunately, repeated failures at reforestation are not uncommon on gopher-infested units, sometimes spanning decades (Crouch, 1971; Barnes, 1979).

Damage reduction usually has involved the use of toxic baits to reduce pocket gopher populations (e.g., Case and Jasch, 1994; Crouch and Frank, 1979). However, the habitat still remains favorable for pocket gopher occupancy after their populations are reduced, and pocket gopher populations can recover rapidly (Witmer et al., 1996). Understanding reoccupation rates of burrow systems provides information useful for determining the frequency and timing of lethal control of gopher populations. It also demonstrates the utility of integrating into a control program methods aimed at deterring reoccupation of a site by pocket gophers.

As a follow-up to a field study evaluating the efficacy of two rodenticide baits for reducing forest pocket gopher populations in reforestation units, we monitored gopher activity plots where the pocket gophers had been removed. This allowed us to determine the rate at which burrow systems were reoccoupied.

2. Methods

2.1. Study area

The study was conducted in south-central Oregon in the Rouge River National Forest. Shelterwood reforestation units with a history of pocket gopher damage, located within a mixed-conifer habitat within the study

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area, were used to evaluate and compare the efficacies of strychnine oat groat bait and diphacinone paraffin bait blocks (Campbell et al., 1992). Three study units were baited with 0.5% strychnine oat groats and three units were baited with 0.005% diphacinone paraffin bait blocks. Study units ranged from about 4.8 to 14 ha and were at approximately 1600 m elevation. Slopes were gentle to moderate with soil and moisture conditions suitable for production of the high quality timber found adjacent to the units. The area usually has snow cover from November through March.

2.2. Activity assessments

Twenty-five 0.027 ha circular plots, each containing active burrow systems, were located on each unit. All plots were at least 30 m from each other and at least 30 m from the edges of the unit. Pocket gopher activity was indexed by the open-hole method (Engeman et al., 1993; Richens, 1967) where two burrows in each plot were opened and then checked for plugging after 48 h. Pocket gophers maintain closed burrow systems and most often will plug or close any openings into their systems. Plot activity was determined three days before baiting in early October and again one month after baiting. Plots found inactive after the one month check most likely had their resident gopher killed by the toxic bait, although some natural mortality may have occurred. Only the plots inactive one month post-baiting were used to evaluate reoccupation rates.

Pocket gopher activity within these plots was again determined 6 months later, soon after the snow melted. Lack of mound building by gophers during this season creates difficulty in locating burrows for open-hole assessments. Thus, when burrows could be found, we modified our open-hole method by opening three burrows. We also applied two other activity assessment methods to each plot. First, all mounds found within the plots at this time were smoothed, then the plots rechecked for mound activity 48 h later. The last indicator for overwinter activity was presence or absence of soil casts in snow. If all three monitoring methods failed to indicate activity in a plot, then the plot was classified as inactive. Activity again was monitored one year after baiting using the open-hole method, as for the one month evaluation. Comparisons of activity among strychnine- and diphacinone-baited plots were made using Fisher's "exact" test.

3. Results

One month post-baiting, a total of 73 of the 150 plots were found to be inactive over the six toxicant-treated study units. These inactive plots were monitored for a return to activity at six months and 1 yr (Table 1). After six months, 63 of the 73 plots (86%) were classified as active. After 1 yr, 70 of the 73 plots (96%) were classified as active.

Table 1
The number (%) of plots one month after toxic baiting that remained inactive after 6 months and one year in south-central Oregon

		Start	Number (%) inactive at:	
Unit	Toxicant	1 mo	6 mo	1 yr
1	strychnine	16	2 (12.5%)	1 (6.3%)
2	strychnine	19	5 (26.3%)	1 (5.3%)
3	strychnine	11	2 (18.2%)	0 (0.0%)
	Subtotal	46	9 (19.6%)	2 (4.3%)
4	diphacinone	8	0 (0.0%)	1 (12.5%)
5	diphacinone	8	1 (12.5%)	0 (0.0%)
6	diphacinone	11	0 (0.0%)	0 (0.0%)
	Subtotal	27	1 (3.7%)	1 (3.7%)
	Total	73	10 (13.7%)	3 (4.1%)

After six months, a larger proportion ($p = 0.08$, Fisher's "exact" test) of plots treated in strychnine-baited units remained inactive (19.6%) than in the diphacinone bait block units (3.7%). However, after one year inactive plots in strychnine-baited units and plots in the diphacinone bait block units showed similar low levels of inactivity (4.3 and 3.7%, respectively; $p = 1.00$, Fisher's "exact" test).

4. Discussion

Originally, efficacy using radio-collared gophers was reported at 72% on the strychnine units and 62% on the diphacinone units (Campbell et al., 1992). Although this difference in efficacy was not statistically significant (Campbell et al., 1992), this result still suggests that perhaps more surviving gophers were available on the diphacinone unit to reoccupy burrow systems. Even though a difference in the proportion of plots remaining inactive after 6 months was indicated between strychnine-baited and diphacinone bait block units, the important point is that return to activity was over 80% for both treatments. After 1 yr only 4% of plots remained inactive, regardless of the bait type. These findings extend the results of Witmer et al. (1996), who rechecked 25 burrow systems in northwestern Washington 10 weeks (in the springtime) after the radio-collared resident animals had been removed. They found that 88% (22) of the burrow systems had been reoccupied. Our 86% return to activity in only six months and 96% after 1 yr point to the difficulties in solely relying on direct pocket gopher population reductions in reforestation units to curb seedling damage.

Most pocket gopher damage to seedlings occurs over winter (e.g., Crouch, 1971; Barnes, 1973; Burton and

Black, 1978) and our plots primarily returned to activity at this time when repeated treatments could not have been applied. Control of pocket gophers in the spring often is difficult because burrows in which to place baits are not easily located until gophers increase burrowing and mound building activity. A second application of the toxic bait may have to be applied very shortly after the first application to reduce the number of animals surviving the first treatment.

Hansen (1960) reported an annual natural mortality rate of 75% in pocket gopher populations. Thus, a toxic bait program would be effective if it provided substantial additional mortality, probably to a total annual rate of at least 90% (Teipner et al., 1983). Toxic baits can rapidly reduce large populations over a large area, however, the food resources and burrow systems remain in place. Coupled with the high reproductive and dispersal potentials of these rodents, repopulation of toxicant-treated units is often very rapid, as demonstrated here. Repeated toxic bait applications are often needed to provide adequate population suppression until the seedlings have grown beyond this vulnerable size class (Bonar, 1995; Campbell, 1993; Sullivan, 1986). Depending on factors such as climate, seedling species, seedling vigor and planting size, seedlings are vulnerable to gopher damage for up to 10 yr after planting (Marsh and Steele, 1992). Thus, an integrated approach (Fall and Jackson, 1998) is most likely to reduce damage. For example, in conjunction with, or in place of toxic baits, vegetation on the site might be managed with herbicides or by other means to make the habitat less suitable for high densities of pocket gophers (e.g., Engeman et al., 1995). Competitive vegetation also can be controlled so that conifers outgrow vulnerable gopher damage years more quickly (Crouch, 1979). Similarly, timber harvest and site preparation could be conducted such that the soil is less disturbed, and therefore less suitable for burrowing, and also so that the preferred plants of the pocket gopher's diet are less likely to proliferate.

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References

Barnes Jr, V.G., 1973. Pocket gophers and reforestation in the Pacific Northwest: a problem analysis. USDI Fish and Wildlife Service, Special Scientific Report—Wildlife No. 155, Washington, DC, 18pp.

Barnes, Jr, V.G., 1979. Survival and growth of ponderosa pine seedlings injured by pocket gophers. Tree Planters' Notes 29, 20–23.

Bonar, R.E., 1995. The Northern Pocket Gopher—Most of What You Thought You Might Want to Know, but Hesitated to Look Up. USDA Forest Service, Technology and Development Program 2400-Timber, T02E11, 62pp.

Borrecco, J.E., Black, H.C., 1990. Animal damage problems and control activities on national forest system lands. Vertebrate Pest Conference, Vol. 14, pp. 192–198.

Burton, D.H., Black, H.C., 1978. Feeding habits of Mazama pocket gophers in south-central Oregon. J. Wildlife Management 42, 383–390.

Campbell, D.L., 1993. Reinvasion by forest rodents: How can we maintain reduced populations? Field Rodent Symposium Reno, NV, p. 16.

Campbell, D.L., Farley, J.P., Hegdal, P.L., Engeman, R.M., Krupa, H.W., 1992. Field efficacy evaluation of diphacinone paraffin bait blocks and strychnine oat groats for control of forest pocket gophers (*Thomomys* spp.). Vertebrate Pest Conference, Vol. 15, pp. 299–302.

Case, R.M., Jasch, B.A., 1994. Pocket gophers. In: Hygnstrom, S.E., Timm, R.M., Larson, G.E. (Eds.), Prevention and Control of Widlife Damage. University of Nebraska, Lincoln, pp. B17–B29.

Crouch, G.L., 1971. Susceptibility of ponderosa, Jeffery and lodgepole pines to pocket gophers. Northwest Sci. 45, 252–256.

Crouch, G.L., 1979. Atrazine improves survival and growth of ponderosa pine threatened by vegetative competition and pocket gophers. Forest Sci. 25, 99–111.

Crouch, G.L., 1986. Pocket gopher damage to conifers in western forests: a historical and current perspective on the problem and its control. Vertebrate Pest Conference. Vol. 12, pp. 196–198.

Crouch, G.L., Frank, L.R., 1979. Poisoning and trapping pocket gophers to protect conifers in northeastern Oregon. USDA Forest Service Research Note, Pacific North West Forest and Range Experiment Station., Portland, OR, PNW-261, 8pp.

Engeman, R.M., Barnes, V., Anthony, R.M., Krupa, H.W., 1995. Vegetative management for reducing damage to ponderosa pine seedlings from Mazama pocket gophers. Crop Protection 14, 505–508.

Engeman, R.M., Campbell, D.L., Evans, J., 1993. A comparison of 2 activity measures for northern pocket gophers. Wildlife Soc. Bull. 21, 70–73.

Fall, M.W., Jackson, W.B., 1998. A new era of vertebrate pest control? An introduction. Int. Biodeterioration Biodegradation 42, 85–91.

Hansen, R.M., 1960. Age and reproductive characteristics of mountain pocket gophers in Colorado. J Mammalogy. 41, 323–335.

Marsh, R.E., Steele, R.W., 1992. Pocket gophers. In: Black, H.C. (Ed.), Silvicultural Approaches to Animal Damage Management in Pacific Northwest Forests. USDA/USFS, Pacific Northwest Research Station, Portland, OR, pp. 205–230.

Richens, V.B., 1967. The status and use of gophacide. Vertebrate Pest Conference, Vol. 3, pp. 118–125.

Sullivan, T.P., 1986. Understanding the resiliency of small mammals to population reduction: poison or population dynamics? In: Richards, C.G.J., Ku, T.Y. (Eds.), Control of Mammal Pests. Taylor & Francis, London. pp. 69–82. (Suppl. to Tropical Pest Management 32, 69–82.)

Teipner, C.L., Garton, E.O., Nelson Jr, L., 1983. Pocket gophers in forest ecosystem. USDA Forest ServiceFirest Range Experiment Station General Technical Report. INT-154. 53pp.

Ward, A.L., Keith, J.O., 1962. Feeding habits of pocket gophers on mountain grasslands. Black Mesa, Colorado. Ecology 43, 744–749.

Witmer, G.W., Sayler, R.D., Pipas, M.J., 1996. Biology and habitat use of the Mazama pocket gopher (*Thomomys mazama*) in the Puget Sound area Washington. Northwest Sci. 70, 93–98.